Nearshore Wave-Topography Interactions

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LONG-TERM GOAL

The long-term goal of nearshore processes research (hence our program) is to develop a predictive understanding of the fluid dynamics of a random wave field shoaling over the complicated bathymetry of a natural beach and the response of the beach to those overlying wave and current motions.

OBJECTIVES

Our principle focus in recent years has been to develop understanding of nearshore variability on time scales of days to years (the time scales for which predictions become useful for society). Bathymetric evolution is generally significant at these scales and behavior of the system becomes more dependent on the nature of feedback within the system than on the details of component processes. Our primary objective is to understand the link between system feedback mechanisms and system behavior.

APPROACH

Strong feedback systems such as the nearshore often exhibit complexity which is difficult to anticipate. Thus long time series, collected at low-cost and at a variety of sites, are an important goal. Over the last decade we have developed and refined a video remote sensing approach called the Argus program. We continue to improve Argus capabilities and the infrastructure needed to work with the data.

WORK COMPLETED

The Argus program continues to develop on many fronts. There are now nine regular sites spanning three continents, each returning data to the Coastal Imaging Lab on an hourly or daily basis. Over the last year, a new five-camera site was installed at Egmond, The Netherlands, to complement an earlier site at Noordwijk on the southern Dutch Coast. We hope this comparison will help explain previously-documented differences in interannual behavior between these sites. A new station was also installed at Muriwai Beach on the west coast of New Zealand to sample the extreme dissipative conditions of the Southern Ocean.

We have also continued upgrades to the system. Earlier, PC-based stations were upgraded to SGI Unix-based platforms at Duck, NC, Palm Beach, Australia, San Diego, CA and Noordwijk, The Netherlands. We have also moved to a database approach to handling of image meta-data (particularly image geometry), vastly simplifying data extraction from imagery. In July, 1998, we hosted the second Argus User Workshop at OSU. Twenty-one visitors from five countries attended, many staying well beyond the week for ongoing collaborations.

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A major effort of the last year was participation if the SandyDuck field experiment. The abundance of ground truth data should allow us to better understand the nature of the video time series data we collect and how geophysical variables can best be extracted. A second component of the effort was testing of a jet-ski survey system originally developed by Reg Beach.

Finally, a careful analysis of the existing archive of CRAB data has been completed by Nathaniel Plant for his PhD. Strong interannual signals have been extracted and modelled.

RESULTS

Sixteen years of CRAB data from the FRF at Duck, NC, were analyzed to extract simple descriptors of bar behavior. Several times through the sample period, offshore sand bars diffused away while new sand bars were created near the shoreline before moving offshore over a several year period. A model was formulated for bar position variability, based on movement toward an equilibrium position dependent only on wave height at a rate which depended on wave energy available and degree of dis-equilibrium. The model was surprisingly successful in explaining both low-frequency adjustment of the new bar and annual response to varying wave conditions (figure 1). Intriguingly, the least squares fit to the data yielded parameters which support a break point model for bar movement (Plant et al., in review).

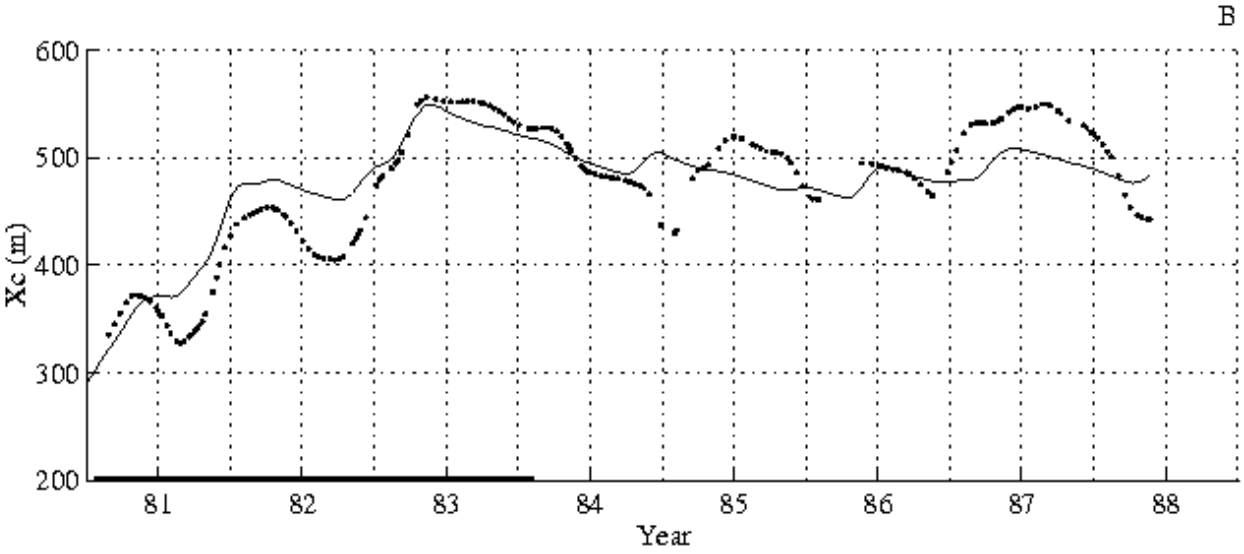

Figure 1. Comparison of observed bar crest position (light colored line) with position predicted by a simple equilibrium bar model (dark dots) over the seven years lifetime of one of the sand bars observed at Duck, NC. The model was calibrated with 1981-83 data (dark line at base of figure). The model captures both the transient adjustment period and the more traditional annual variability.

Comparisons of the jet-ski survey system against CRAB ground truth data from SandyDuck demonstrate the accuracy of the new system to be around 0.15m vertical. This system has subsequently been used for surveying the high energy beaches in the Pacific Northwest.

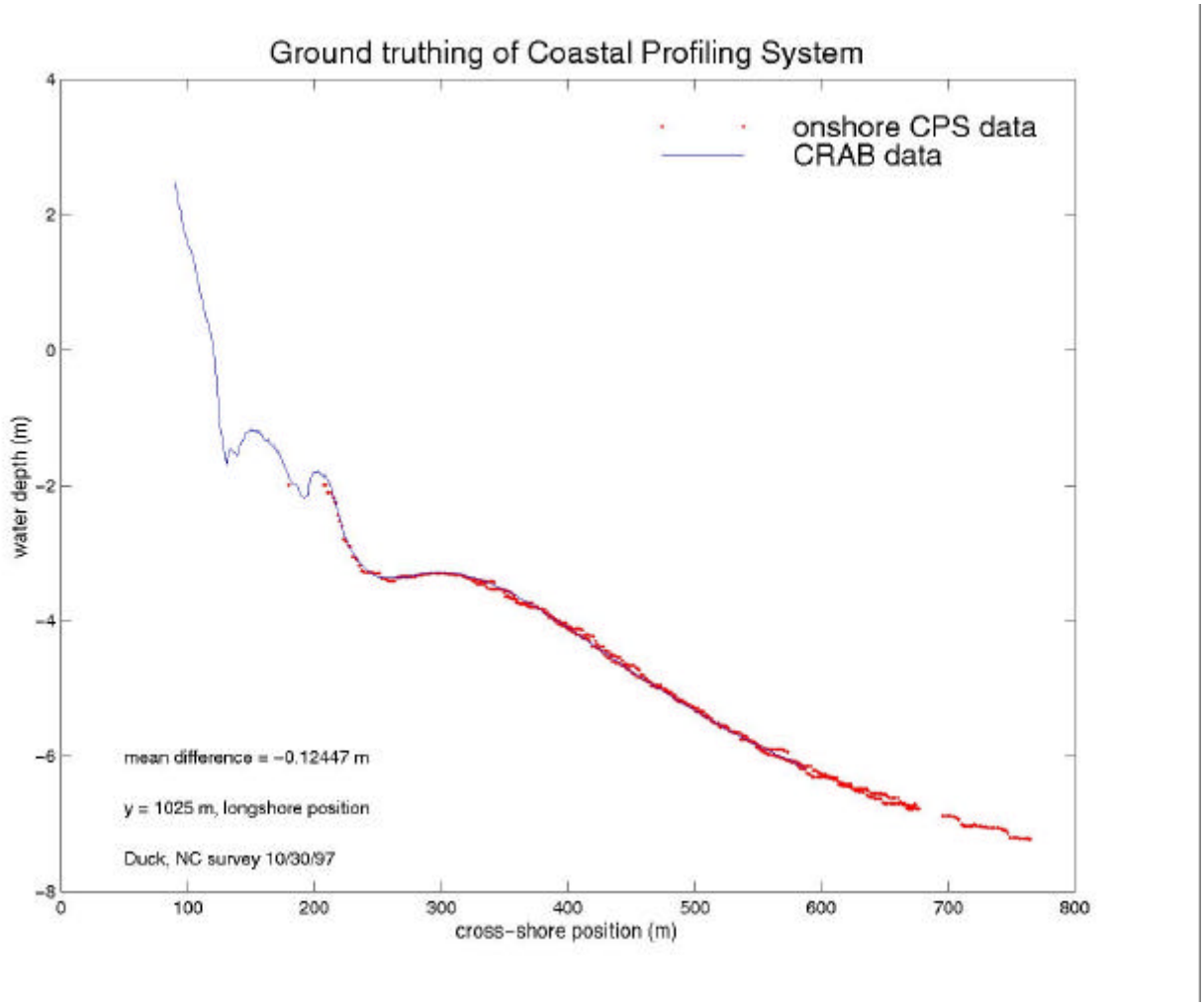

Figure 2. Example comparison of bathymetry collected using the CRAB (solid blue line) and that from the jet-ski survey system (red dots). The mean difference of 12 cm, removed in the plot, was a function of an early fathometer placement and has subsequently been corrected.

Data from the Argus program continue to collect and form the basis for a number of analyses. We continue to observe system configurations which boggle our imagination (figure 3). Discovering the organization of this variability and differences between observations from different Argus sites continues to be a primary goal.

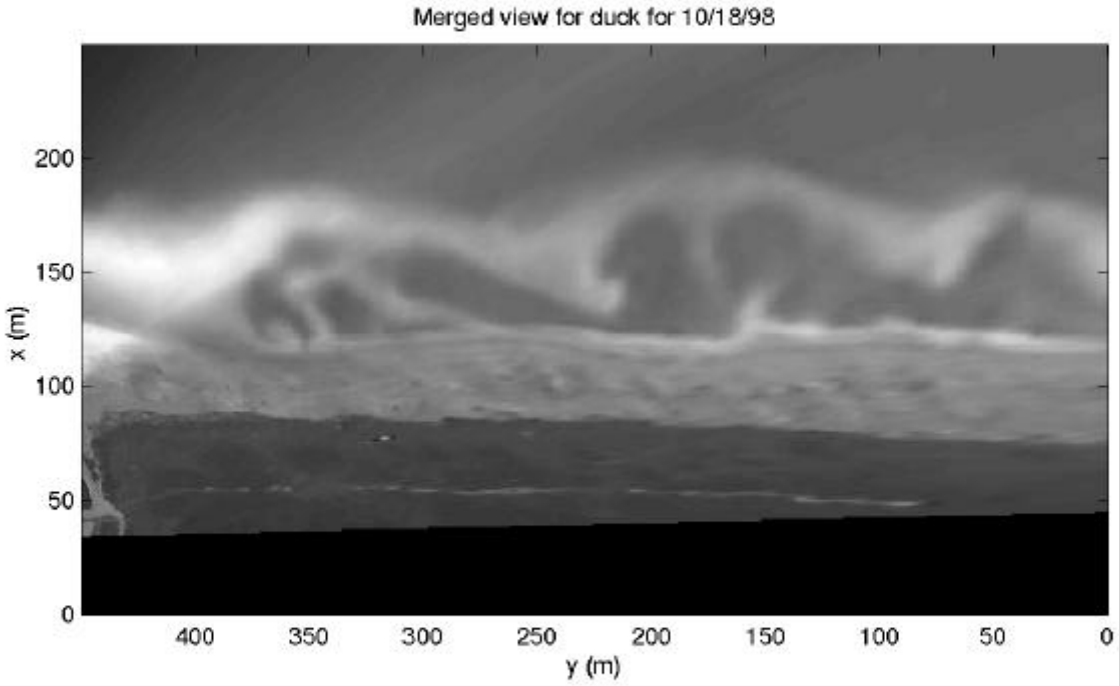

Figure 3. Rectified time exposure from Duck, NC, for October 10, 1998. The gray at the top of this image is seaward, while the dark bottom band (x < about 80 m) is dune grass with beach sand spanning the region 80 < x < 125. White bands in the region 125 < x < 200 mark enhanced dissipation over what appears to be the most complex sand bar system that we have observed at Duck. This figure is a composite from two cameras, the one on the left having a higher gain, hence appears brighter.

IMPACT/APPLICATION

The nearshore is a region of increasing interest for naval forces. Data and understanding acquired in the Argus program will be very relevant to issues of environmental prediction, particularly regarding the "shelf life" of bathymetry data. Because the Argus program includes nine sites spanning the full range of beach types, our understanding will not be limited to the current Duck prototype. Techniques developed to quantify EO imagery for the extraction of geophysical variables can be readily applied to moving platform remote sensing, with the addition of frame-dependent image navigation.

TRANSITIONS

We continue to work collaboratively with NRL (particularly Todd Holland) and the Army Corps (with the Field Research Facility Staff and with Bill Curtis) on the mutual development of EO-based remote sensing techniques for the littoral environment. Several of the techniques under development are of interest both to the NRL and NAVOCEANO, and have been the subject of joint visits. Data from the Argus program is routinely used in Navy METOC.

RELATED PROJECTS

1. Joint work with Dr. Todd Holland, NRL-SSC
2. Bathymetry IPT with NAVOCEANO, NRL
3. Bathy Blind Test, NAVOCEANO
4. LRS program collaboration
5. NICOP joint program with several European groups
6. NICOP joint program with Graham Symonds of Australia
7. Joint work with Bill Curtis of U.S. Army Corps on EO techniques
8. Miscellaneous other involvements too unusual to mention.

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